PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-107540

(43)Date of publication of application : 24.04.1998

(51)Int.Cl. H01Q 15/00

G01C 7/04

G01C 15/06

G08G 1/16

(21)Application number : 08-256404

(22)Date of filing : 27.09.1996

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(54) RADIO WAVE REFLECTOR

(57)Abstract:

PROBLEM TO BE SOLVED: To improve the detection sensitivity of a vehicle position using a radio wave by improving a scattering characteristic of the surface of the radio wave reflector.

SOLUTION: A plurality of radiation elements 13 in resonance with a radio wave are arranged in an array at an interval of (d) on the surface of the radio reflector 11. A reflected signal level is increased with respect to a resonated radio wave.

The reflected signal level is selectively increased with respect to a radio wave made incident at a prescribed incident angle depending on a wavelength of a radio wave and the interval (d) so as to improve the rear scattering characteristic much more thereby improving the detection sensitivity furthermore.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

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[Date of extinction of right]

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] It is the electric-wave reflector which is an electric-wave reflector installed on the road surface in order to detect the location of a car using the electric wave of the wavelength more than a millimeter wave, and is characterized by said electric-wave reflector having the radiating element which reflects the electric wave by which incidence is resonated and carried out to the frequency of said electric wave on the front face.

[Claim 2] Said electric wave is an electric-wave reflector according to claim 1 to which it is characterized by arranging two or more said radiating elements at intervals of [from which the product of the spacing d along the travelling direction of a car and sintheta toward which only the include angle which has the wavelength lambda defined beforehand and is beforehand defined to the travelling direction of a car inclines serves as an integral multiple of wavelength lambda] d by being transmitted caudad and carrying out incidence to said radiating element by the incident angle theta.

[Claim 3] Said electric-wave reflector is an electric-wave reflector characterized by being the electric-wave reflector installed on the road surface in order to detect the location of a car using the electric wave of the wavelength more than a millimeter wave, and forming irregularity in the front face.

[Claim 4] Said irregularity is an electric-wave reflector according to claim 3 which has the shape of a gear tooth of a saw and is characterized by reflecting the electric wave which carried out incidence in the direction which carried out incidence.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is installed on a road surface and relates to the electric-wave reflector which detects the location of a car using an electric wave.

[0002]

[Description of the Prior Art] Conventionally, in order to perform unattended operation of a car, the technique of detecting the relative position of the car to a roadway is known.

[0003] For example, the technique of laying a light reflex tape to a roadway, forming two-piece 1 set of photosensors in a car below at the width of face of a reflective tape, and detecting a car posture in a publication-number No. 106910 [one to] official report is indicated. In addition, a road surface is photoed with a mounted camera and the technique of detecting the relative position of the car to a white line by extracting the white line in a screen is also known.

[0004]

[Problem(s) to be Solved by the Invention] However, when using a light reflex tape, sufficient light reflex may not be obtained with the dirt of a tape etc.

Moreover, at any rate, if it was indoor, since it had the influence of rain, snow, etc., and light was often reflected by not only a light reflex tape but the puddle when it is especially rainy weather, on the street [actual] had the problem which cannot detect a car location with high precision. When a mounted camera was used, it was easy to be influenced of the weather similarly, and the time of rainy weather was not enough as the contrast of a white line and other parts of a road surface, and there was a problem which cannot extract a white line with high precision.

[0005] Then, as shown in drawing 7 , there is an idea of detecting a car location, using the electric wave of the wavelength more than a millimeter wave. That is, the electric-wave reflector 2 as a rain marker is formed in the predetermined location of a road surface 1, for example, the center of a road surface 1, and a car location is detected by detecting the existence of the electric-wave reflector 2 from the reflectivity of the electric wave which formed the electric-wave transmitter-receiver 4 in the car 3, and was transmitted to it. However, since reflectivity may change with change of the radio-scattering property in the front face of the electric-wave reflector 2 etc., in order to detect a car location with a sufficient precision, a certain cure is needed. As shown in drawing 8 , especially to transmit an electric wave ahead [slanting / 7] only the include angle psi inclined to the travelling direction 6 of a car 3 from an antenna 5 and perform location detection of the front electric-wave reflector 2, it is necessary to improve the reflection property to back.

[0006] The purpose of this invention is offering the electric-wave reflector which can improve the dispersion property of the front face of an electric-wave reflector, and can improve the detection sensitivity of a car location using an electric wave.

[0007]

[Means for Solving the Problem] This invention is the electric-wave reflector installed on the road surface, in order to detect the location of a car using the electric wave of the wavelength more than a millimeter wave, and it is the electric-wave reflector characterized by said electric-wave reflector having the

radiating element which reflects the electric wave by which incidence is resonated and carried out to the frequency of said electric wave on the front face. If this invention is followed, in the front face of an electric-wave reflector, it resonates in the frequency of the electric wave for location detection, and has the radiating element which reflects the electric wave by which incidence is carried out. For example, a radiating element can be formed by printing the configuration of a half-wave length dipole antenna, a patch antenna, etc. Since the reflectivity of the electric wave from the front face of an electric-wave reflector increases, a backscattering property can be improved and detection sensitivity (S/C ratio) can be improved.

[0008] Moreover, it is characterized by arranging more than one at intervals of [from which the product of the spacing d toward which only the include angle which has the wavelength lambda which defines said electric wave beforehand by this invention, and is beforehand defined to the travelling direction of a car inclines, and to which it is caudad transmitted, incidence is carried out to said radiating element by the incident angle theta, and said radiating element meets the travelling direction of a car, and sintheta serves as an integral multiple of wavelength lambda] d. If this invention is followed, it will have the wavelength lambda defined beforehand, it will be transmitted to the lower part toward which only the include angle beforehand defined to the travelling direction of a car inclines, and incidence of the electric wave used for car location detection will be carried out to a radiating element by the incident angle theta. The difference of the advance distance of the electric wave which reflects by the adjoining radiating element and returns in the direction of incidence can make reflective signal level max, without denying mutually, since it becomes the product of spacing d and sintheta and this value serves as an integral multiple of the wavelength lambda of an electric wave.

[0009] Furthermore, this invention is the electric-wave reflector installed on the road surface, in order to detect the location of a car using the electric wave of the wavelength more than a millimeter wave, and said electric-wave reflector is an

electric-wave reflector characterized by forming irregularity in the front face. If this invention is followed, since irregularity is formed in the front face of an electric-wave reflector, the backscattering property over the electric wave by which incidence is carried out to a front face can be improved rather than a smooth front face, and the detection sensitivity of a car location using an electric wave can be improved.

[0010] Moreover, by this invention, said irregularity has the shape of a gear tooth of a saw, and is characterized by reflecting the electric wave which carried out incidence in the direction which carried out incidence. If this invention is followed, since the irregularity of the shape of a gear tooth of a saw will be formed in the front face of an electric-wave reflector and the electric wave which carried out incidence will be reflected in the direction of incidence, the electric wave by which incidence is carried out can be strongly reflected in the direction of incidence, and the detection sensitivity of a car location using an electric wave can be improved.

[0011]

[Embodiment of the Invention] Drawing 1 and drawing 2 show the rough configuration of the electric-wave reflector 11 as one gestalt of operation of this invention. A perspective view with partial drawing 1 and drawing 2 show a partial side-face sectional view, respectively. The electric-wave reflector 11 is installed on the road surface 12 of a road, in order to use the electric wave of the wavelength more than a millimeter wave and to perform location detection etc., while cars, such as an automobile, run. On the front face of the electric-wave reflector 11, with the ingredient which has conductivity, such as a metallic foil, two or more radiating elements 13 are printed in the shape of an array, and are arranged. The fixed spacing d is formed between each radiating element 13. The array of such a radiating element 13 is the same structure as the microstrip antenna (abbreviated name "MSA") without electric supply Rhine for supplying high-frequency power with a predetermined phase which carried out arrangement printing of the radiating element non-supplied electric power at the

shape of an array.

[0012] The body of the electric-wave reflector 11 is formed by the insulator 14 which has endurance and electric insulation. A coating with the endurance currently used for the display path on the street as an insulator 14 etc. is used. When installing in an actual road etc., you may make it cover a front-face [of the electric-wave reflector 11], and radiating element 13 top by the insulating coat further for protection.

[0013] A radiating element 13 has a circular patch and the notch prepared in the both ends of the one diameter. If a radiating element 13 has the resonance frequency which becomes settled from the configuration and the electric wave of resonance frequency carries out incidence as an electromagnetic wave, it will be excited and will emit the electric wave of the frequency alternatively. The magnitude of a radiating element 13 is roughly equivalent to the wavelength lambda to resonance frequency, and becomes so small that wavelength lambda is short. As other formats of a radiating element 13, a rectangular patch, a rectangular half-wave length dipole antenna, etc. can also be used. Moreover, if the electric wave of two or more frequencies is used for location detection and resonance frequency is changed, a system which identifies a frequency by the electric-wave reflector 11 side is realizable.

[0014] Drawing 3 shows change of the reflection coefficient to the incident angle when arranging a radiating element 13 in the shape of an array at intervals of [fixed] d, as shown in drawing 1 . Drawing 4 shows the condition that incidence of the electric wave is carried out to two or more radiating elements 13 as an incident wave 17, respectively. As for each incident wave 17, incidence of the incident angle theta is carried out in the fixed condition to the normal 18 of each radiating element 13. Consequently, between the electric waves reflected by the radiating element 13 which adjoins in the direction of incidence, the path difference delta as shown by the 1st following formula arises.

[0015]

delta = dxsintheta -- (1)

If path difference delta serves as an integral multiple of the wavelength lambda of an electric wave, the electric wave reflected towards the direction of incidence of an electric wave by the adjoining radiating element 13 will be emphasized as compared with the electric wave reflected towards other directions. Namely, when the 2nd following formula is materialized considering n as an integer (n= 1, 2 and 3, --), reflective signal level can be theoretically stopped to attenuation of about 13dB by theta= 0 in the direction of a normal 18 as compared with the time of carrying out incidence.

[0016]

[Equation 1]

$$d = \frac{\lambda}{\sin\theta} \times n \qquad \cdots (2)$$

[0017] An incident wave 17 is usually emitted from the antenna 20 which made only the fixed include angle psi (psi=pi / 2-theta) incline caudad to the travelling direction of a car, as shown in drawing 8 . if it is psi=pi / 2, theta= 0 [i.e.,], reflective signal level will serve as max -- although kicked -- a car -- present -- reign -- only sensing of the electric-wave reflector 11 corresponding to a value can be performed. When operating the car which is running at a rate with more practical seeing the slanting front, the location of the electric-wave reflector 11 can be preceded to some extent, and can be detected.

[0018] Drawing 5 shows the rough configuration of the electric-wave reflector 41 of the gestalt of further others of operation of this invention. Drawing 5 (1) shows a partial side-face sectional view, and drawing 5 (2) shows a partial top view, respectively. The electric-wave reflector 41 of this operation gestalt consists of the insulating material as the insulating material 14 of the operation gestalt of drawing 1 with the same whole, and the irregularity 42 which acts as a square drill-like corner reflector is formed in the front face. Let magnitude of irregularity 42 be extent do not consider that is smooth to the wavelength of the electric wave for location detection. By forming such irregularity 42 in a front face, a monotonous twist can also improve the backscattering property over an electric

wave, and the detection sensitivity by the electric wave can be raised.

[0019] Drawing 6 shows the condition that an incident wave 45 is reflected in the direction of incidence as a reflected wave 46, as a gestalt of further others of this invention by the electric-wave reflector 51 by which the irregularity of the shape of a gear tooth of a saw is formed in a front face. Drawing 6 (1) shows the condition of returning a reflected wave 46 in the direction parallel to the direction of incidence from the sloping direction to the normal of the front face of the electric-wave reflector 51 to the incident wave 45 by which incidence is carried out. Drawing 6 (2) shows the condition of returning directly the incident wave 45 by which incidence is carried out at right angles to the front face of the electric-wave reflector 51 in the direction of incidence as a reflected wave 46. Drawing 6 (3) shows the partial appearance of the electric-wave reflector 51. The electric wave which carries out incidence of the irregularity of the front face of the electric-wave reflector 51 by considering as the shape of a gear tooth of the unsymmetrical saw which made the inclination loose in the direction of incidence of an electric wave is reflected in the direction of incidence, or the direction parallel to it, and a backscattering property can be improved rather than the symmetrical irregularity 42 of the shape of a square drill as shown in drawing 5 .

[0020]

[Effect of the Invention] As mentioned above, according to this invention, in the front face of an electric-wave reflector, it resonates in the frequency of an electric wave and has the radiating element which reflects the electric wave by which incidence is carried out. Since the reflectivity of the electric wave from the front face of an electric-wave reflector increases, a backscattering property can be improved and detection sensitivity can be improved.

[0021] Moreover, since according to this invention it is set up so that the spacing d of a radiating element may make reflective signal level max, detection sensitivity can be raised.

[0022] Furthermore, according to this invention, only by forming irregularity in the front face of an electric-wave reflector, the backscattering property over the

electric wave by which incidence is carried out to a front face can be improved rather than a smooth front face, and the detection sensitivity of a car location can be improved.

[0023] Moreover, according to this invention, the irregularity of the shape of a gear tooth of a saw can be formed in the front face of an electric-wave reflector, the electric wave by which incidence is carried out can be reflected in the direction of incidence, a backscattering property can be improved, and the detection sensitivity of a car location using an electric wave can be improved.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the partial perspective view showing the rough configuration of the electric-wave reflector 11 of one gestalt of operation of this invention.

[Drawing 2] It is the side-face sectional view of the electric-wave reflector 11 of drawing 1 .

[Drawing 3] It is the graph which shows the relation between the incident angle to the electric-wave reflector 11 of drawing 1 , and a reflection coefficient.

[Drawing 4] It is the rough side-face sectional view showing the condition that an

incident wave 17 carries out incidence to the electric-wave reflector 11 of drawing 1 by the incident angle theta.

[Drawing 5] It is the partial side-face sectional view and top view showing the rough configuration of the electric-wave reflector 41 of the gestalt of further others of operation of this invention.

[Drawing 6] It is the partial side-face sectional view and perspective view showing the rough configuration of the electric-wave reflector 51 of the gestalt of further others of operation of this invention.

[Drawing 7] It is the simplified front view showing the rough configuration relevant to the car location detection by the conventional technique.

[Drawing 8] It is the simplified side elevation showing the rough configuration relevant to the car location detection by the electric-wave reflector by the conventional technique.

[Description of Notations]

11, 41, 51 Electric-wave reflector

12 Road Surface

13 Radiating Element

14 Insulator

17 45 Incident wave

18 Normal

20 Antenna

46 Reflected Wave

42 Irregularity

[Translation done.]

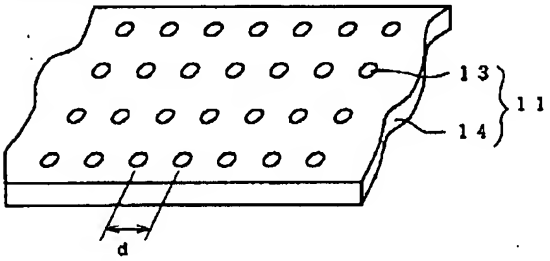
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

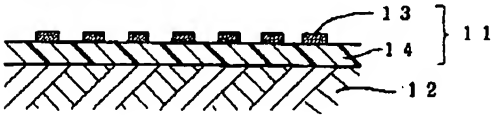
3.In the drawings, any words are not translated.

DRAWINGS

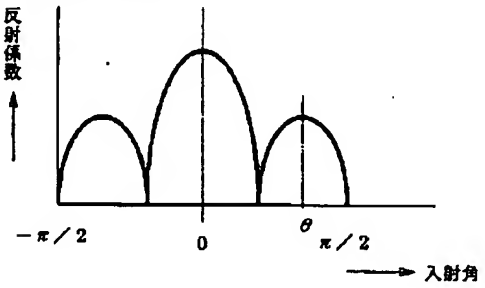
[Drawing 1]



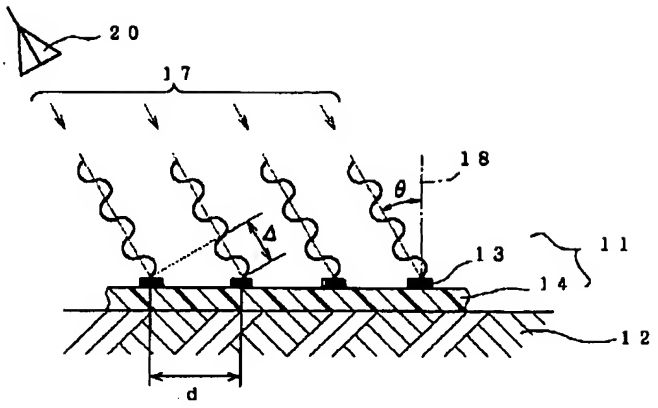
[Drawing 2]



[Drawing 3]



[Drawing 4]



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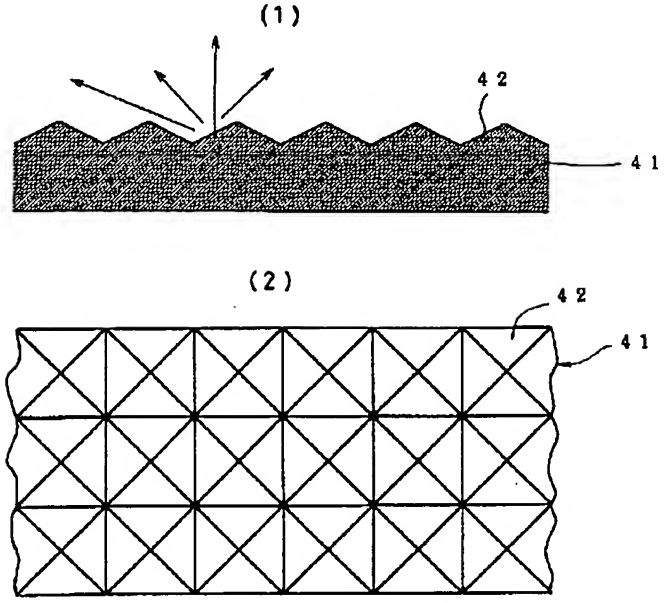

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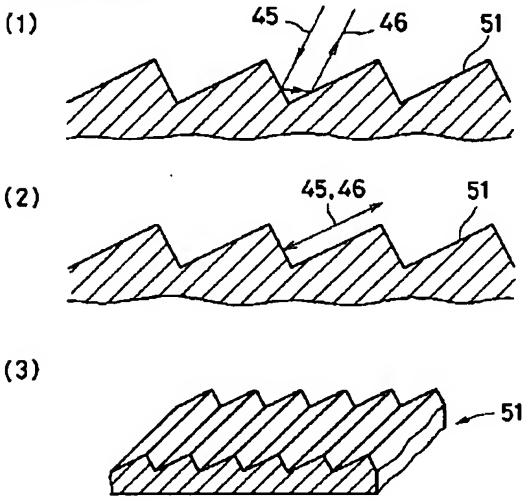
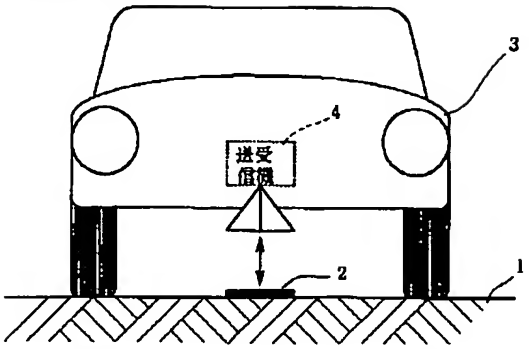
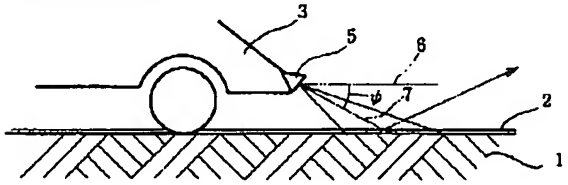


[Drawing 7]



[Drawing 8]



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平10－107540

(43)公開日　平成10年(1998)４月24日

(51)Int.Cl.[6]	識別記号	ＦＩ		
Ｈ０１Ｑ　15/00		Ｈ０１Ｑ　15/00		
Ｇ０１Ｃ　7/04		Ｇ０１Ｃ　7/04		
15/06		15/06		Ｔ
Ｇ０８Ｇ　1/16		Ｇ０８Ｇ　1/16		Ｃ

審査請求　未請求　請求項の数４　ＯＬ　（全５頁）

(21)出願番号　特願平8－256404

(22)出願日　平成８年(1996)９月27日

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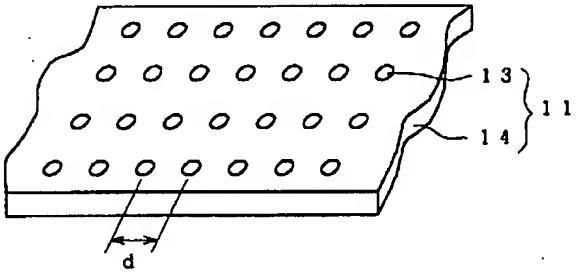
(54)【発明の名称】　電波反射体

(57)【要約】
【課題】　電波反射体の表面の散乱特性を改善し、電波を用いる車両位置の検出感度を向上する。
【解決手段】　電波反射体１１の表面には、電波と共振する複数の放射素子１３が間隔ｄをあけてアレイ状に配列される。共振する電波に対しては、反射信号レベルを大きくすることができる。電波の波長および間隔ｄによって、一定の入射角度で入射する電波に対する反射信号レベルが選択的に大きくなり、後方散乱特性を一層改善して、検出感度を一層向上させることができる。



【特許請求の範囲】
【請求項１】　ミリ波以上の波長の電波を用いて車両の位置を検出するために路面上に設置された電波反射体であって、
前記電波反射体はその表面に、前記電波の周波数に共振し、入射される電波を反射する放射素子を有していることを特徴とする電波反射体。
【請求項２】　前記電波は、予め定める波長λを有し、車両の進行方向に対して予め定める角度だけ傾斜する下方に送信されて、前記放射素子に入射角θで入射し、
前記放射素子は、車両の進行方向に沿う間隔ｄとｓｉｎθとの積が、波長λの整数倍となるような間隔ｄで複数個配列されていることを特徴とする請求項１記載の電波反射体。
【請求項３】　ミリ波以上の波長の電波を用いて車両の位置を検出するために路面上に設置された電波反射体であって、
前記電波反射体はその表面に、凹凸が形成されていることを特徴とする電波反射体。
【請求項４】　前記凹凸は、のこぎりの歯状であり、入射した電波を入射した方向に反射することを特徴とする請求項３に記載の電波反射体。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、路面上に設置され、電波を用いて車両の位置を検出する電波反射体に関する。
【０００２】
【従来の技術】従来より、車両の自動運転を行うために走路に対する車両の相対位置を検出する技術が知られている。
【０００３】例えば、特開平１－１０６９１０号公報には、走路に光反射テープを敷設し、車両に反射テープの幅以下に２個１組の光センサを設けて車両姿勢を検出する技術が開示されている。この他、車載カメラで路面を撮影し、画面内の白線を抽出することで白線に対する車両の相対位置を検出する技術も知られている。
【０００４】
【発明が解決しようとする課題】しかしながら、光反射テープを用いる場合にはテープの汚れ等により十分な光反射が得られない場合がある。また、屋内ならともかく、実際の路上は雨や雪等の影響があり、特に雨天の場合には光反射テープのみならず水たまりによっても光がよく反射されるため、高精度に車両位置を検出できない問題があった。車載カメラを用いる場合も同様に天候の影響を受けやすく、雨天時等では白線と路面の他の部分とのコントラストが十分でなく、白線を高精度に抽出できない問題があった。
【０００５】そこで、図７に示すように、ミリ波以上の波長の電波を用いて、車両位置を検出する考えがある。すなわち、路面１の所定位置、例えば路面１の中央にレーンマーカとしての電波反射体２を設け、車両３に電波送受信機４を設け、送信した電波の反射強度から電波反射体２の有無を検出することで車両位置を検出するのである。但し、電波反射体２の表面での電波散乱特性などの変化により反射強度が変化し得るため、精度良く車両位置を検出するためには何らかの対策が必要となる。特に、図８に示すように、アンテナ５から電波を車両３の進行方向６に対して角度ψだけ傾斜した斜め前方７に送信し、前方の電波反射体２の位置検出を行う場合は、後方への反射特性を改善する必要がある。
【０００６】本発明の目的は、電波反射体の表面の散乱特性を改善し、電波を用いる車両位置の検出感度を向上することができる電波反射体を提供することである。
【０００７】
【課題を解決するための手段】本発明は、ミリ波以上の波長の電波を用いて車両の位置を検出するために路面上に設置された電波反射体であって、前記電波反射体はその表面に、前記電波の周波数に共振し、入射される電波を反射する放射素子を有していることを特徴とする電波反射体である。本発明に従えば、電波反射体の表面には、位置検出用電波の周波数に共振し、入射される電波を反射する放射素子を有する。たとえば、半波長ダイポールアンテナやパッチアンテナなどの形状を印刷することによって、放射素子を形成することができる。電波反射体の表面からの電波の反射強度が増大するので、後方散乱特性を改善し、検出感度（Ｓ／Ｃ比）を向上することができる。
【０００８】また本発明で前記電波は、予め定める波長λを有し、車両の進行方向に対して予め定める角度だけ傾斜する下方に送信されて、前記放射素子に入射角θで入射し、前記放射素子は、車両の進行方向に沿う間隔ｄとｓｉｎθとの積が、波長λの整数倍となるような間隔ｄで複数個配列されていることを特徴とする。本発明に従えば、車両位置検出に用いる電波は、予め定める波長λを有し、車両の進行方向に対して予め定める角度だけ傾斜する下方に送信されて、放射素子に入射角θで入射される。隣接する放射素子で反射して入射方向に戻る電波の進行距離の差は、間隔ｄとｓｉｎθとの積となり、この値が電波の波長λの整数倍となるので、相互に打ち消すことなく、反射信号レベルを最大にすることができる。
【０００９】さらに本発明は、ミリ波以上の波長の電波を用いて車両の位置を検出するために路面上に設置された電波反射体であって、前記電波反射体はその表面に、凹凸が形成されていることを特徴とする電波反射体である。本発明に従えば、電波反射体の表面に凹凸が形成されているので、表面に入射される電波に対する後方散乱特性を平滑な表面よりも改善し、電波を用いる車両位置の検出感度を向上することができる。

【００１０】また本発明で前記凹凸は、のこぎりの歯状であり、入射した電波を入射した方向に反射することを特徴とする。本発明に従えば、電波反射体の表面にのこぎりの歯状の凹凸が形成され、入射した電波を入射方向に反射するので、入射される電波を、入射方向に強く反射させることができ、電波を用いる車両位置の検出感度を向上することができる。

【００１１】

【発明の実施の形態】図１および図２は、本発明の実施の一形態としての電波反射体１１の概略的な構成を示す。図１は部分的な斜視図、図２は部分的な側面断面図をそれぞれ示す。電波反射体１１は、自動車などの車両が走行中にミリ波以上の波長の電波を用いて位置検出などを行うために、道路の路面１２上に設置される。電波反射体１１の表面上には、金属箔など導電性を有する材料で、複数の放射素子１３がアレイ状に印刷されて配置される。各放射素子１３間には、一定の間隔ｄが設けられる。このような放射素子１３の配列は、所定の位相で高周波電力を供給するための給電ラインがない、無給電放射素子をアレイ状に配置印刷したマイクロストリップアンテナ（略称「ＭＳＡ」）と同一構造である。

【００１２】電波反射体１１の本体は、耐久性および電気絶縁性を有する絶縁体１４によって形成される。絶縁体１４としては、道路上の表示に使用されている耐久性のある塗料などが使用される。実際の道路などに設置す

$$\Delta = d \times \sin\theta$$

行路差Δが電波の波長λの整数倍となると、隣接する放射素子１３によって電波の入射方向に向けて反射される電波は、他の方向に向けて反射される電波に比較して強調される。すなわち、ｎを整数（ｎ＝１，２，３，…）として、次の第２式が成立する場合に、反射信号レベル

$$d = \frac{\lambda}{\sin\theta} \times n$$

【００１７】入射波１７は、通常、図８に示すように、車両の進行方向に対して下方に一定の角度ψ（$\psi = \pi/2 - \theta$）だけ傾斜させたアンテナ２０から放射される。$\psi = \pi/2$、すなわち$\theta = 0$であれば反射信号レベルは最大となるけれども、車両の現在位値に対応する電波反射体１１のセンシングしか行うことができない。斜め前方を見た方が、実用的な速度で進行している車両の運転を行う場合は、電波反射体１１の位置をある程度先行して検出することができる。

【００１８】図５は本発明の実施のさらに他の形態の電波反射体４１の概略的な形状を示す。図５（１）は部分的な側面断面図、図５（２）は部分的な平面図をそれぞれ示す。本実施形態の電波反射体４１は、全体が図１の実施形態の絶縁物１４と同様な絶縁物からなり、その表面には、四角錐状のコーナリフレクタとして作用する凹凸４２が形成されている。凹凸４２の大きさは、位置検出用の電波の波長に対して平滑とは見做されない程度とする場合は、電波反射体１１の表面および放射素子１３の上を、さらに保護用の絶縁皮膜で覆うようにしてもよい。

【００１３】放射素子１３は、円形のパッチと、その一直径の両端に設けられる切欠き部とを有する。放射素子１３は、その形状から定まる共振周波数を有し、共振周波数の電波が電磁波として入射すると、励振されて、その周波数の電波を選択的に放射する。放射素子１３の大きさは、共振周波数に対する波長λに概略的に対応し、波長λが短いほど小さくなる。放射素子１３の他の形式として、方形のパッチや半波長ダイポールアンテナなどを用いることもできる。また、複数の周波数の電波を位置検出用に使用し、共振周波数を変えれば、電波反射体１１側で周波数を識別するようなシステムを実現することができる。

【００１４】図３は、図１に示すように、一定間隔ｄで放射素子１３をアレイ状に配置するときの入射角に対する反射係数の変化を示す。図４は、複数の放射素子１３にそれぞれ入射波１７として電波が入射される状態を示す。各入射波１７は、各放射素子１３の法線１８に対して、入射角θが一定の状態で入射される。この結果、入射方向に隣接する放射素子１３によって反射される電波間には次の第１式で示すような行路差Δが生じる。

【００１５】

…（１）

は、法線１８の方向に$\theta = 0$で入射するときに比較して、理論上、約１３ｄＢ程度の減衰に留めることができる。

【００１６】

【数１】

…（２）

する。このような凹凸４２を表面に形成することによって、電波に対する後方散乱特性を平板よりも改善し、電波による検出感度を向上させることができる。

【００１９】図６は本発明のさらに他の形態として、のこぎりの歯状の凹凸が表面に形成される電波反射体５１によって、入射波４５が反射波４６として入射方向に反射される状態を示す。図６（１）は、電波反射体５１の表面の法線に対し、傾斜した方向から入射される入射波４５に対して、反射波４６を入射方向に平行な方向へ戻す状態を示す。図６（２）は、電波反射体５１の表面に垂直に入射される入射波４５を、反射波４６として入射方向に直接的に戻す状態を示す。図６（３）は、電波反射体５１の部分的な外観を示す。電波反射体５１の表面の凹凸を電波の入射方向に傾斜を緩くした非対称なのこぎりの歯状とすることによって、入射する電波を入射方向またはそれに平行な方向に反射し、図５に示すような四角錐状の対称な凹凸４２よりも後方散乱特性を改善す

ることができる。

【００２０】

【発明の効果】以上のように本発明によれば、電波反射体の表面には、電波の周波数に共振し、入射される電波を反射する放射素子を有する。電波反射体の表面からの電波の反射強度が増大するので、後方散乱特性を改善し、検出感度を向上することができる。

【００２１】また本発明によれば、放射素子の間隔ｄが反射信号レベルを最大にするように設定されるので、検出感度を向上させることができる。

【００２２】さらに本発明によれば、電波反射体の表面に凹凸を形成するだけで、表面に入射される電波に対する後方散乱特性を平滑な表面よりも改善し、車両位置の検出感度を向上することができる。

【００２３】また本発明によれば、電波反射体の表面にのこぎりの歯状の凹凸を形成して、入射される電波を入射方向に反射して後方散乱特性を改善し、電波を用いる車両位置の検出感度を向上することができる。

【図面の簡単な説明】

【図１】本発明の実施の一形態の電波反射体１１の概略的な構成を示す部分的な斜視図である。

【図２】図１の電波反射体１１の側面断面図である。

【図３】図１の電波反射体１１への入射角と反射係数との関係を示すグラフである。

【図４】図１の電波反射体１１に入射角θで入射波１７が入射する状態を示す概略的な側面断面図である。

【図５】本発明の実施のさらに他の形態の電波反射体４１の概略的な構成を示す部分的な側面断面図および平面図である。

【図６】本発明の実施のさらに他の形態の電波反射体５１の概略的な形状を示す部分的な側面断面図および斜視図である。

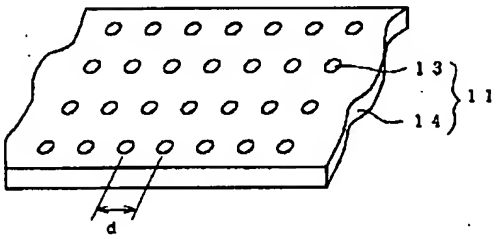
【図７】従来技術による車両位置検出に関連する概略的な構成を示す簡略化した正面図である。

【図８】従来技術による電波反射体による車両位置検出に関連する概略的な構成を示す簡略化した側面図である。

【符号の説明】

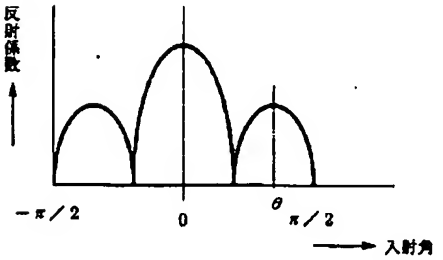
１１，４１，５１　電波反射体
１２　路面
１３　放射素子
１４　絶縁体
１７，４５　入射波
１８　法線
２０　アンテナ
４６　反射波
４２　凹凸

【図１】

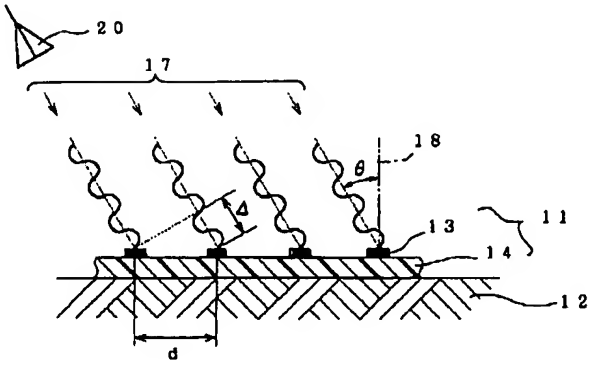


【図２】

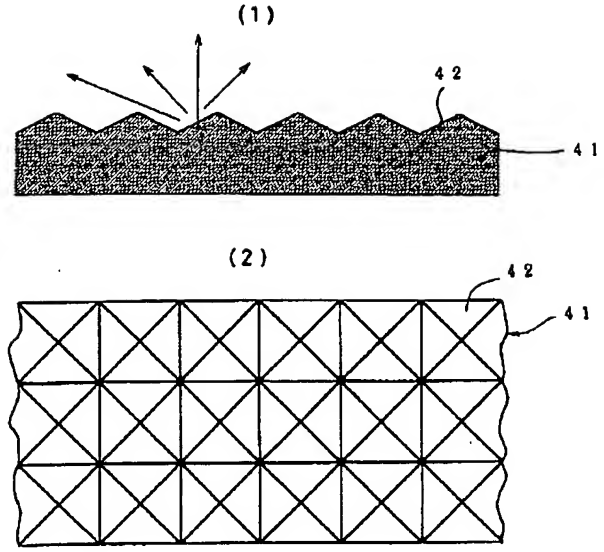
【図３】



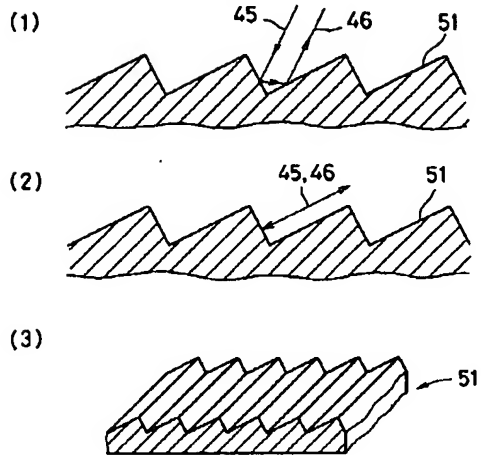
【図４】



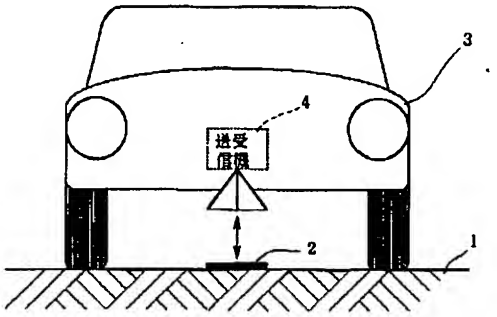
【図5】



【図6】



【図7】



【図8】